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(74) Agents: WARBURG, Richard, J. et al.; Foley & Lardner, P.O. Box 80278, San Diego, CA 92138-0278 (US).

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(71) Applicant *(for all designated States except US)*: **BIOSITE DIAGNOSTICS, INC.** [US/US]; 11030 Roselle Street, San Diego, CA 92121 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **DAHLEN, Jeffrey, R.** [US/US]; 10555 Kemmerton Road, San Diego, CA 92126 (US). **VALKIRS, Gunars, E.** [US/US]; 2893 Paseo del Sol, Escondido, CA 92025 (US). **BUECHLER, Kenneth, F.** [US/US]; 12523 Manifesto Place, San Diego, CA 92130 (US).

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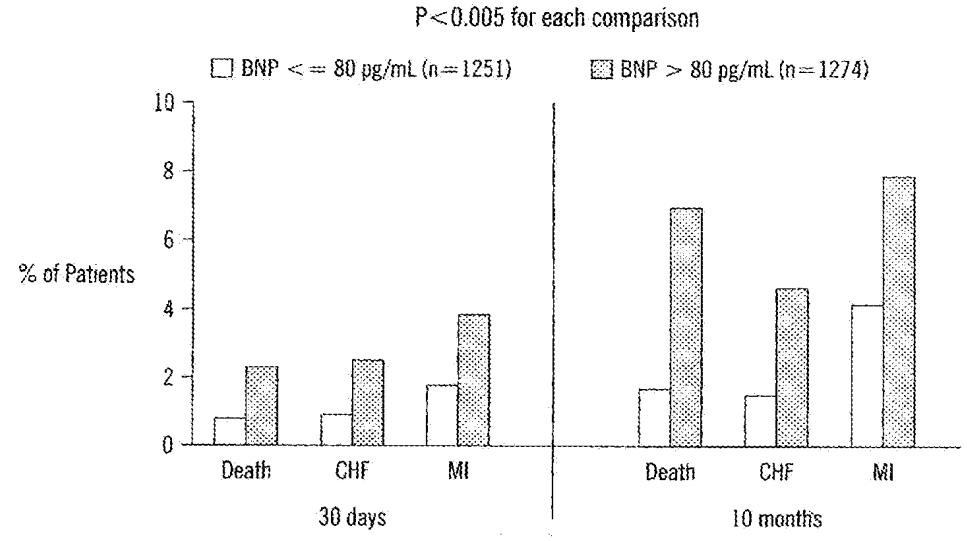
(54) Title: USE OF B-TYPE NATRIURETIC PEPTIDE AS A PROGNOSTIC INDICATOR IN ACUTE CORONARY SYNDROMES



(57) Abstract: The present invention relates to materials and procedures for evaluating the prognosis of patients suffering from acute coronary syndromes. In particular, the level of BNP, or a marker related to BNP, in a patient sample, alone or in combination with one or more other prognostic markers, provides prognostic information useful for predicting near-term morbidity and/or mortality across the entire spectrum of acute coronary syndromes, including unstable angina, non-ST-elevation non-Q wave myocardial infarction, ST-elevation non-Q wave MI, and transmural (Q-wave) MI.

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USE OF B-TYPE NATRIURETIC PEPTIDE AS A PROGNOSTIC INDICATOR IN ACUTE CORONARY SYNDROMES

INTRODUCTION

The present invention relates in part to methods, compositions, and devices for the measurement of BNP, and the use of such measurement in the diagnosis, prognosis, and treatment of patients with acute coronary syndromes.

BACKGROUND OF THE INVENTION

The following discussion of the background of the invention is merely provided to aid the reader in understanding the invention and is not admitted to describe or constitute prior art to the present invention.

The term "acute coronary syndromes" ("ACS") has been applied to a group of coronary disorders that result from ischemic insult to the heart. Patients with ACS form a heterogeneous group, with differences in pathophysiology, clinical presentation, and risk for adverse events. Such patients present to the physician with conditions that span a continuum that includes unstable angina, non-ST-elevation non-Q wave myocardial infarction ("NST"-"MI"), ST-elevation non-Q wave MI, and transmural (Q-wave) MI. ACS is believed to result largely from thrombus deposition and growth within one or more coronary arteries, resulting in a partial or complete occlusion of the artery, and frequently involves rupture of the plaque, resulting in an ischemic injury. ACS may also be precipitated by a coronary vasospasm or increased myocardial demand. For review, *see, e.g.*, Davies, *Clin. Cardiol.* 20 (Supp. I): I2-I7 (1997).

The seriousness of ACS is underlined by the morbidity and mortality that follow the ischemic insult. For example, workers have estimated that within four to six weeks of presentation with ACS, the risk of death or a subsequent MI is 8-14%, and the rate of death, MI, or refractory ischemia is 15-25%. Theroux and Fuster, *Circulation* 97: 1195-1206 (1998) Given that the total number of deaths in the U.S. from acute MI is about 600,000, the search within the art for information that relates to the diagnosis, prognosis, and management of ACS has understandably been extensive. Several potential markers that may provide such information in certain patient populations have been identified, including circulating cardiac troponin levels (*see, e.g.*, Antman *et al.*, *N. Eng. J. Med.* 335: 1342-9 (1996); see also U.S. Patent Nos. 6,147,688, 6,156,521, 5,947,124, and 5,795,725, each of which is hereby incorporated by reference in its

entirety), ST-segment depression (*see, e.g.*, Savonitto *et al.*, *JAMA* 281: 707-13 (1999)), circulating creatine kinase levels (*see, e.g.*, Alexander *et al.*, *Circulation* (Suppl.) 1629 (1998)), and circulating c-reactive protein levels (*see, e.g.*, Morrow *et al.*, *J. Am. Coll. Cardiol.* 31: 1460-5 (1998)).

B-type natriuretic peptide ("BNP" or "BNP-32") is a 32-amino acid neurohormone that is synthesized in ventricular myocardium and released into the circulation in response to ventricular dilation and pressure overload. The functions of BNP, like atrial natriuretic peptide, include natriuresis, vasodilation, inhibition of the renin-angiotensin-aldosterone axis, and inhibition of sympathetic nerve activity. The plasma concentration of BNP is elevated among patients with congestive heart failure (CHF), and increases in proportion to the degree of left ventricular dysfunction and the severity of CHF symptoms. For review, *see, e.g.*, Wiese *et al.*, *Circulation* 102: 3074-9 (2000); Yasue *et al.*, *Circulation* 90: 195-203 (1994); Yoshimura *et al.*, *Circulation* 87: 464-9 (1993); Stein and Levin, *Am. Heart J.* 135: 914-23 (1998); and Omland *et al.*, *Heart* 76: 232-7 (1996).

The precursor to BNP is synthesized as a 108-amino acid molecule, referred to as " pre pro BNP," that is proteolytically processed into a 76-amino acid N-terminal peptide (amino acids 1-76), referred to as "NT pro BNP" and the 32-amino acid mature hormone, referred to as BNP or BNP 32 (amino acids 77-108). It has been suggested that each of these species – NT pro-BNP, BNP-32, and the pre pro BNP – can circulate in human plasma. *See, e.g.*, Tateyama *et al.*, *Biochem. Biophys. Res. Commun.* 185: 760-7 (1992); Hunt *et al.*, *Biochem. Biophys. Res. Commun.* 214: 1175-83 (1995). Pre pro BNP and NT pro BNP, and peptides which are derived from BNP, pre pro BNP and NT pro BNP that are present in the blood as a result of proteolyses of BNP, NT pro BNP and pre pro BNP, are collectively described herein as "markers related to or associated with BNP."

Following the onset of acute MI, the plasma concentration of BNP has been shown to rise rapidly over the first 24 hours, and then to stabilize; patients with large infarcts may have a second peak in BNP concentration several days later. The concentration of BNP, when measured between 1 and 4 days following a transmural infarct, can provide prognostic information that is independent of the left ventricular ejection fraction (LVEF) and other important baseline variables. *See, e.g.*, Talwar *et al.*, *Eur. Heart J.* 21: 1514-21 (2000); Darbar *et al.*, *Am. J. Cardiol.* 78: 284-7 (1996);

Richards *et al.*, *Heart* 81: 114-20 (1999); Omland *et al.*, *Circulation* 93: 1963-9 (1996); Arakawa *et al.*, *J. Am. Coll. Cardiol.* 27: 1656-61 (1996); and Richards *et al.*, *Circulation* 97: 1921-9 (1998).

To date, however, studies evaluating the prognostic implications of increased BNP concentration have been limited to patients with ST-elevation MI, and few data are available with regard to the prognostic implications of BNP following non ST-elevation acute coronary syndromes, including unstable angina and NST-MI. Thus, there remains in the art the need to identify markers useful in evaluating patient prognosis across the entire spectrum of acute coronary syndromes, so that patients at risk of near-term morbidity or and/or death or can be identified and treated.

SUMMARY OF THE INVENTION

The present invention relates to materials and procedures for evaluating the prognosis of patients suffering from acute coronary syndromes. In particular, the level of BNP in a patient sample, alone or in combination with one or more additional prognostic markers, can provide prognostic information useful for predicting near-term morbidity and/or mortality across the entire spectrum of acute coronary syndromes.

In various aspects, the invention relates to materials and procedures for identifying BNP levels, and/or levels of one or more markers related to BNP, that are associated with an increased predisposition to an adverse outcome in a patient; identifying one or more additional prognostic markers that increase the predictive value of a BNP level, or of a marker related to BNP, for such an adverse outcome; using the BNP level, or the level of a marker related to BNP, in a patient, alone or in combination with one or more additional prognostic markers, to determine a patient's prognosis; and using the BNP level, or the level of a marker related to BNP, in a patient, alone or in combination with one or more additional prognostic markers to determine a treatment regimen that improves a patient's prognosis.

Thus, the materials and procedures described herein can be used to identify those patients that are at acute risk for one or more serious complications, including the risk of death, resulting from acute coronary syndromes, and to guide the clinician in treatment of such patients.

In a first aspect, the invention relates to methods for determining the prognosis of a patient diagnosed with an acute coronary syndrome. These methods comprise

identifying a BNP level, or the level of a marker related to BNP, that is associated with an increased predisposition of an adverse outcome resulting from an acute coronary syndrome. Once such a prognostic level is determined, the level of BNP or a related marker, in a patient sample can be measured, and then compared to the prognostic level that is associated with the increased predisposition of the adverse outcome. By correlating the patient level to the prognostic level, the prognosis of the patient can be determined.

The term "BNP" as used herein refers to the mature 32-amino acid BNP molecule itself. As described herein, levels of BNP in patient samples can provide an important prognostic indication of future morbidity and mortality in patients presenting with ACS. As the skilled artisan will recognize, however, other markers related to BNP may also serve as prognostic indicators in such patients. For example, BNP is synthesized as a 108-amino acid pre pro-BNP molecule that is proteolytically processed into a 76-amino acid "NT pro BNP" and the 32-amino acid BNP molecule. Because of its relationship to BNP, the concentration of NT pro-BNP molecule can also provide prognostic information in patients. *See, e.g.*, Fischer *et al., Clin. Chem.* 47: 591-594 (2001); Berger *et al., J. Heart Lung Transplant.* 20: 251- (2001).

The phrase "marker related to BNP" refers to any polypeptide that originates from the pre pro-BNP molecule, other than the 32-amino acid BNP molecule itself. Thus, a marker related to or associated with BNP includes the NT pro-BNP molecule, the pro domain, a fragment of BNP that is smaller than the entire 32-amino acid sequence, a fragment of pre pro-BNP other than BNP, and a fragment of the pro domain. One skilled in the art will also recognize that the circulation contains proteases which can proteolyze BNP and BNP related molecules and that these proteolyzed molecules (peptides) are also considered to be "BNP related" and are additionally subjects of this invention.

The phrase "determining the prognosis" as used herein refers to methods by which the skilled artisan can predict the course or outcome of a condition in a patient. The term "prognosis" does not refer to the ability to predict the course or outcome of a condition with 100% accuracy, or even that a given course or outcome is more likely to occur than not. Instead, the skilled artisan will understand that the term "prognosis" refers to an increased probability that a certain course or outcome will occur; that is, that a course or outcome is more likely to occur in a patient exhibiting a given

characteristic, such as the presence or level of a prognostic indicator, when compared to those individuals not exhibiting the characteristic. For example, as described hereinafter, an ACS patient exhibiting a plasma BNP level greater than 80 pg/mL may be more likely to suffer from an adverse outcome than an ACS patient exhibiting a lower plasma BNP level. For example, in individuals not exhibiting the condition, the chance of a certain course or outcome may be 3%. In such a case, the increased probability that the course or outcome will occur would be any number greater than 3%. In preferred embodiments, a prognosis is about a 5% chance of a given outcome, about a 7% chance, about a 10% chance, about a 12% chance, about a 15% chance, about a 20% chance, about a 25% chance, about a 30% chance, about a 40% chance, about a 50% chance, about a 60% chance, about a 75% chance, about a 90% chance, and about a 95% chance. The term "about" in this context refers to +/- 1%.

A prognosis is often determined by examining one or more "prognostic indicators." These are markers, the presence or amount of which in a patient (or a sample obtained from the patient) signal a probability that a given course or outcome will occur. For example, preferred prognostic indicators in the present invention are BNP and markers related to BNP. As discussed herein, BNP is present in patients suffering from various acute coronary syndromes. When BNP reaches a sufficiently high level in samples obtained from such patients, the BNP level signals that the patient is at an increased probability for morbidity or death, in comparison to a similar patient exhibiting a lower BNP level. A level of a prognostic indicator, such as BNP or a marker related to BNP, that signals an increased probability for morbidity or death is referred to as being "associated with an increased predisposition to an adverse outcome" in a patient.

The skilled artisan will understand that associating a prognostic indicator with a predisposition to an adverse outcome is a statistical analysis. For example, a BNP, or BNP-associated marker, level of greater than 80 pg/mL may signal that a patient is more likely to suffer from an adverse outcome than patients with a level less than or equal to 80 pg/mL, as determined by a level of statistical significance. Statistical significance is often determined by comparing two or more populations, and determining a confidence interval and/or a p value. *See, e.g.*, Dowdy and Wearden, *Statistics for Research*, John Wiley & Sons, New York, 1983. Preferred confidence intervals of the invention are 90%, 95%, 97.5%, 98%, 99%, 99.5%, 99.9% and 99.99%,

while preferred p values are 0.1, 0.05, 0.025, 0.02, 0.01, 0.005, 0.001, and 0.0001. Exemplary statistical tests for associating a prognostic indicator with a predisposition to an adverse outcome are described hereinafter.

The term "correlating," as used herein in reference to the use of prognostic indicators to determine a prognosis, refers to comparing the presence or amount of the prognostic indicator in a patient to its presence or amount in persons known to suffer from, or known to be at risk of, a given condition; or in persons known to be free of a given condition. For example, a BNP level in a patient can be compared to a level known to be associated with an increased disposition for an MI or death. The patient's BNP level is said to have been correlated with a prognosis; that is, the skilled artisan can use the patient's BNP level to determine the likelihood that the patient is at risk for an MI or death, and respond accordingly. Alternatively, the patient's BNP level can be compared to a BNP level known to be associated with a good outcome (*e.g.*, no MI, no death, *etc.*), and determine if the patient's prognosis is predisposed to the good outcome.

In certain embodiments, a prognostic indicator is correlated to a patient prognosis by merely its presence or absence. For example, the presence or absence of ST-segment depression in an electrocardiogram can be correlated with a predisposition to certain conditions. *See, e.g.*, Savonitto *et al.*, *JAMA* 281: 707-13 (1999).

In other embodiments, a threshold level of a prognostic indicator can be established, and the level of the indicator in a patient sample can simply be compared to the threshold level. For example, a BNP level of 80 or 100 pg/mL in a patient sample can be established as a level at which a patient is at an increased disposition for morbidity or death. A preferred threshold level for BNP or a BNP-associated marker of the invention is about 25 pg/mL, about 50 pg/mL, about 75 pg/mL, about 100 pg/mL, about 150 pg/mL, about 200 pg/mL, about 300 pg/mL, about 400 pg/mL, about 500 pg/mL, about 600 pg/mL, about 750 pg/mL, about 1000 pg/mL, and about 2500 pg/mL. The term "about" in this context refers to +/- 10%.

In yet other embodiments, a "nomogram" can be established, by which a level of a prognostic indicator can be directly related to an associated disposition towards a given outcome. The skilled artisan is acquainted with the use of such nomograms to relate two numeric values.

The phrase "acute coronary syndromes" as used herein refers to a group of coronary disorders that result from ischemic insult to the heart. ACS includes unstable angina, non-ST-elevation non-Q wave MI, ST-elevation non-Q wave MI, and transmural (Q-wave) MI. ACS can be divided into non-ST-elevation ACS and ST-elevation ACS, each of which may be associated with certain prognostic indicators and prognoses, as described herein. The phrase "non-ST-elevation acute coronary syndrome" refers to those ACS not associated with an elevated ST component in an electrocardiogram. Non-ST-elevation ACS include unstable angina and non-ST-elevation non-Q wave MI. *See, e.g.*, Nyman *et al.*, Very early risk stratification by electrocardiogram at rest in men with suspected unstable coronary heart disease. The RISC Study Group, *J. Intern. Med.* 1993; 234: 293-301 (1993); Patel *et al.*, Early continuous ST segment monitoring in unstable angina: prognostic value additional to the clinical characteristics and the admission electrocardiogram, *Heart* 75: 222-28 (1996); Patel *et al.*, Long-term prognosis in unstable angina. The importance of early risk stratification using continuous ST segment monitoring, *Eur. Heart J.* 19: 240-49 (1998); and Lloyd-Jones *et al.*, Electrocardiographic and clinical predictors of acute myocardial infarction in patients with unstable angina pectoris, *Am. J. Cardiol.* 81: 1182-86 (1998), each of which is hereby incorporated by reference in its entirety.

Diagnosis of ACS generally, and non-ST-elevation ACS in particular, is well known to the skilled artisan. *See, e.g.*, Braunwald *et al.*, Unstable angina: diagnosis and management, Clinical practice guideline no. 10 (amended), AHCPR publication no. 94 0602. Rockville, Md.: Department of Health and Human Services, (1994); Yusuf *et al.*, Variations between countries in invasive cardiac procedures and outcomes in patients with suspected unstable angina or myocardial infarction without ST elevation-OASIS (Organisation to Assess Strategies for Ischaemic Syndromes) Registry Investigators, *Lancet* 352:507–514 (1998); Savonitto *et al.*, Prognostic value of the admission electrocardiogram in acute coronary syndromes, *JAMA* 281:707-713 (1999); Klootwijk and Hamm, Acute coronary syndromes: diagnosis, *Lancet* 353 (suppl II): 10-15 (1999), each of which is hereby incorporated by reference in its entirety.

The phrase "adverse outcome" as used herein refers to morbidity or mortality suffered by a patient subsequent to the onset of ACS in the patient. For example, a patient may present to a clinician with ACS; an adverse outcome could be a subsequent MI, subsequent onset of angina, subsequent onset of congestive heart failure, or

subsequent death. An adverse outcome is said to occur within the "near term" if it occurs within about 10 months of the onset of ACS.

In certain embodiments, one or more additional prognostic indicators can be combined with a level of BNP, or a related marker, in a patient sample to increase the predictive value of BNP or the related marker as a prognostic indicator. The phrase "increases the predictive value" refers to the ability of two or more combined prognostic indicators to improve the ability to predict a given outcome, in comparison to a prediction obtained from any of the prognostic indicators alone. For example, a BNP level of X pg/mL may predict a 10% chance of a subsequent MI in the patient; and a cardiac troponin I level of Y ng/mL may predict a 5% chance of a subsequent MI. But the presence of both a BNP level of X pg/mL and a cardiac troponin I level of Y ng/mL in sample(s) obtained from the same patient may indicate a much higher chance of a subsequent MI in the patient. Preferred additional prognostic indicators of the invention are circulating cardiac-specific troponin levels, ST-segment depression, circulating creatine kinase levels, and circulating c-reactive protein levels.

The skilled artisan will understand that the plurality of prognostic indicators need not be determined in the same sample, or even at the same time. For example, one prognostic indicator may not appear in serum samples until some time has passed from the onset of ACS. Nevertheless, combining, for example, a cardiac troponin I level taken at 1 hour with a BNP level obtained at 48 hours, may provide the skilled artisan with an increased predictive value in comparison to either measurement alone.

Additionally, the increased predictive value need not be an increased probability of an adverse outcome. For example, a cardiac troponin I level taken at 1 hour may indicate a 5% chance of a subsequent MI. But when combined with a later BNP level that indicates a good prognosis in the patient, the result may be to reduce the predicted chance that the patient will suffer a subsequent MI.

The skilled artisan will also understand that a plurality of prognostic indicators may also include both a BNP level and the levels of one or more markers related to BNP; or, alternatively, may be two or more different markers related to BNP. For example, the levels of BNP and NT pro-BNP may be combined to determine the prognosis of a patient with an increased predictive value in comparison to either measurement alone.

The phrase "cardiac-specific troponin" refers to cardiac-specific isoforms of troponin I and T, and/or to complexes comprising at least one cardiac-specific troponin isoform. *See, e.g.*, U.S. Patent Nos. 6,147,688, 6,156,521, 5,947,124, and 5,795,725, each of which is hereby incorporated by reference in its entirety. Particularly preferred are methods that combine BNP and one or more cardiac-specific troponin isoforms as prognostic markers to determine the prognosis of a patient.

The term "patient sample" refers to a sample obtained from a living person for the purpose of diagnosis, prognosis, or evaluation. In certain embodiments, such a sample may be obtained for the purpose of determining the outcome of an ongoing condition or the effect of a treatment regimen on a condition. Preferred patient samples are blood samples, serum samples, plasma samples, cerebrospinal fluid, and urine samples.

In another aspect, the invention relates to methods for determining a prognostic panel comprising a plurality of prognostic markers that can be used to determine the prognosis of a patient diagnosed with an acute coronary syndrome. These methods preferably comprise identifying a level of BNP, or a marker related to BNP, that is associated with an increased predisposition of an adverse outcome resulting from an acute coronary syndrome, and identifying one or more additional prognostic markers that increase the predictive value in comparison to that obtained from the use of BNP or the related marker alone as a prognostic indicator.

Once the plurality of markers has been determined, the levels of the various markers making up the panel can be measured in one or more patient sample(s), and then compared to the diagnostic levels determined for each marker, as described above.

In yet another aspect, the invention relates to methods for determining a treatment regimen for use in a patient diagnosed with an acute coronary syndrome. The methods preferably comprise determining a level of one or more prognostic markers as described herein, and using the prognostic markers to determine a prognosis for a patient. One or more treatment regimens that improve the patient's prognosis by reducing the increased disposition for an adverse outcome associated with the acute coronary syndrome can then be used to treat the patient.

In a further aspect, the invention relates to kits for determining the prognosis of a patient diagnosed with an acute coronary syndrome. These kits preferably comprise devices and reagents for measuring a BNP level, or the level of a marker related to

BNP, in a patient sample, and instructions for performing the assay. Optionally, the kits may contain one or more means for converting a BNP or related marker level to a prognosis. Additionally, the kits may provide devices and reagents for determining one or more additional prognostic markers to be combined with a level of BNP, or a marker related to BNP, in a patient sample.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows Kaplan-Meier curves relating BNP concentration to 10-month mortality. Patients were divided into quartiles based on the concentration of BNP at enrollment.

Figure 2 shows the association between BNP concentration and 10-month mortality. Patients were divided into quartiles based on the concentration of BNP at enrollment. Quartiles were recalibrated for each of the subgroups shown. STEMI = ST elevation myocardial infarction; NSTEMI = non ST elevation myocardial infarction; UA = unstable angina.

Figure 3 shows a stepwise logistic regression model showing the relationship between selected baseline clinical variables and 10-month mortality. Cardiac troponin I (cTnI) and BNP quartiles were forced into the final model. Odds ratios and 95% confidence intervals are shown. In addition to the variables shown in the figure, the final model included history of hyperlipidemia or peripheral vascular disease; prior therapy with diuretics, ACE inhibitors, nitrates, or heparin; heart rate; blood pressure; and creatinine clearance.

Figure 4 shows the numbers of patients in 3 adverse outcome groups (death, congestive heart failure (CHF), and myocardial infarction (MI)) at 30 days and 10 months, among patients with a BNP concentration above and below a prespecified threshold of 80 pg/mL.

Figure 5 shows the relationship between BNP concentration and 10-month mortality, using a threshold of 80 pg/mL to define BNP elevation. STEMI = ST elevation myocardial infarction; NSTEMI = non ST elevation myocardial infarction; UA – unstable angina.

Figure 6 shows the numbers of patients in 3 adverse outcome groups (death, congestive heart failure (CHF), and myocardial infarction (MI)) at 30 days and 10

months, among patients with a BNP concentration above and below a threshold of 100 pg/mL.

Figure 7 shows the relationship between BNP concentration and 10-month mortality, using a threshold of 100 pg/mL to define BNP elevation. STEMI = ST elevation myocardial infarction; NSTEACS = non ST elevation acute coronary syndrome; UA – unstable angina.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Use of BNP as a prognostic marker in ACS

As demonstrated herein, the concentration of BNP, measured in the first few days after an acute coronary event, predicts the risk for morbidity and mortality across the entire spectrum of acute coronary syndromes. The prognostic utility of BNP persists after adjusting for clinical evidence of heart failure, as well as other important predictors of mortality, including clinical characteristics, ECG changes and cardiac troponin I.

Previous cohort studies have demonstrated that following acute MI, higher plasma concentrations of BNP and the N-terminal fragment of its prohormone (NT-pro BNP) are associated with larger infarct size (Arakawa *et al.*, *Cardiology* 85: 334-40 (1994); Horio *et al.*, *Am. Heart J.* 126: 293-9 (1993)), adverse ventricular remodeling (Nagaya *et al.*, *Am. Heart J.* 135: 21-8 (1998)), and lower ejection fraction and an increased risk for the development of congestive heart failure and death (Talwar *et al.*, *Eur. Heart J.* 21: 1514-21 (2000); Darbar *et al.*, *Am. J. Cardiol.* 78: 284-7 (1996); Richards *et al.*, *Heart* 81: 114-20 (1999); Omland *et al.*, *Circulation* 93: 1963-9 (1996); Arakawa *et al.*, *J. Am. Coll. Cardiol.* 27: 1656-61 (1996); Richards *et al.*, *Circulation* 97: 1921-9 (1998)). These prior studies have each included fewer than 150 patients, and focused on relatively homogenous groups of patients with ST elevation MI. The following exemplary embodiments extend these findings in patients with non-ST elevation acute coronary syndromes, including unstable angina.

As demonstrated herein, a single measurement of BNP, performed a median of 40 hours after the onset of ischemic symptoms, provides powerful risk-stratification across the entire spectrum of acute coronary syndromes. The prognostic implications of BNP levels are distinct from those of myocyte necrosis; that is, even among patients with unstable angina, the degree of BNP elevation is of prognostic significance.

Moreover, even after correcting for variables such as history of hypertension, heart failure, and prior diuretic or ACE inhibitor use, BNP remained predictive of long-term mortality. Thus, despite heterogeneity in pathophysiology and clinical presentation between patients with ST elevation MI, non-ST elevation ACS, and unstable angina, increasing BNP concentration was predictive of mortality in each of these subgroups, suggesting that activation of the cardiac neurohormonal system may be a unifying feature among patients at high risk for death across the entire spectrum of acute coronary syndromes.

The association between BNP and long-term mortality was independent of clinical evidence of congestive heart failure, as well as cardiac Troponin I, ECG changes, and other known predictors of mortality in ACS. In fact, BNP appeared to be a more powerful predictor of long-term mortality than any other variable measured. In addition, higher BNP levels were associated with an increased risk for the development of nonfatal endpoints, including new or progressive heart failure and myocardial infarction. Finally, it appears that a BNP threshold of 80 to 100 pg/mL, indicative of neurohormonal activation in patients with congestive heart failure, also performs well among patients with ACS.

Also, unlike traditional cardiac biomarkers used to predict risk among patients with ACS, and particularly non-ST elevation ACS, BNP has a putative role in the counter-regulatory response to ischemic injury. As such, it may act as an index of the size or severity of the ischemic insult, as well as the degree of underlying impairment in left ventricular function. For example, in an animal model of transmural myocardial infarction, BNP gene expression was augmented 3-fold in the left ventricle within 4 hours after the onset of coronary artery ligation, and importantly, tissue concentrations of BNP were increased in non-infarcted as well as infarcted regions. Hama *et al.*, *Circulation* 92: 1558-64 (1995). Moreover, it has been demonstrated that BNP increases rapidly, and transiently, following exercise testing in patients with chronic stable angina, and that the degree of BNP elevation is closely correlated with the size of the ischemic territory as measured using nuclear SPECT imaging. Marumoto *et al.*, Clin. Sci. (Colch.) 88: 551-6 (1995).

Furthermore, BNP increases transiently following uncomplicated percutaneous transluminal coronary angioplasty even in the absence of changes in pulmonary capillary wedge pressure. Tateishi *et al. Clin. Cardiol.* 23: 776-80 (2000); Kyriakides

et al., *Clin. Cardiol.* 23: 285-8 (2000). Several small cross-sectional studies have shown that BNP and Nt-pro BNP concentrations are higher among patients with unstable angina than among patients with stable angina or among healthy controls. Talwar *et al.*, *Heart* 84: 421-4 (2000); Kikuta *et al.*, *Am. Heart J.* 132: 101-7 (1996). In one of these studies (Kikuta *et al.*), BNP elevation appeared to correlate with echocardiograph findings of regional wall motion abnormalities but not with hemodynamic data obtained at the time of simultaneous cardiac catheterization; furthermore, after medical stabilization, wall motion abnormalities improved and BNP levels fell significantly. Taken together, these prior studies suggest that myocardial ischemia may augment BNP synthesis and release, even in the absence of myocardial necrosis or pre-existing left ventricular dysfunction. Reversible ischemia may lead to a transient increase in left ventricular wall stress, which may be sufficient to cause BNP elevation.

Use of BNP for determining a treatment regimen

A useful prognostic indicator such as BNP can help clinicians select between alternative therapeutic regimens. For example, patients with elevation in cardiac troponin T or I following an acute coronary syndrome appear to derive specific benefit from an early aggressive strategy that includes potent antiplatelet and antithrombotic therapy, and early revascularization. Hamm *et al.*, *N. Engl. J. Med.* 340: 1623-9 (1999); Morrow *et al.*, *J. Am. Coll. Cardiol.* 36: 1812-7 (2000); Cannon *et al.*, *Am. J. Cardiol.* 82: 731-6 (1998). Additionally, patients with elevation in C-reactive protein following myocardial infarction appear to derive particular benefit from HMG-CoA Reductase Inhibitor therapy. Ridker *et al.*, *Circulation* 98: 839-44 (1998). Among patients with congestive heart failure, pilot studies suggest that ACE inhibitors may reduce BNP levels in a dose dependent manner. Van Veldhuisen *et al.*, *J. Am. Coll. Cardiol.* 32: 1811-8 (1998).

Similarly, "tailoring" diuretic and vasodilator therapy based on Nt-pro BNP levels may improve outcomes. Troughton *et al.*, *Lancet* 355: 1126-30 (2000). Finally, in a single pilot study of 16 patients found that randomization to an ACE inhibitor rather than placebo following Q-wave MI was associated with reduced BNP levels over the subsequent 6-month period. Motwani *et al.*, *Lancet* 341: 1109-13 (1993). Because BNP is a counter-regulatory hormone with beneficial cardiac and renal effects, it is likely that a change in BNP concentration reflects improved ventricular function and

reduced ventricular wall stress. A recent article demonstrates the correlation of NT pro-BNP and BNP assays (Fischer *et al., Clin. Chem.* 47: 591-594 (2001). It is a further objective of this invention that the concentration of BNP can be used to guide diuretic and vasodilator therapy to improve patient outcome. Additionally, the measurement of one or more markers related to BNP, such as NT-proBNP, for use as a prognostic indicator for patients suffering from acute coronary syndromes, is within the scope of the present invention.

Recent studies in patients hospitalized with congestive heart failure suggest that serial BNP measurements may provide incremental prognositic information as compared to a single measurement; that is, assays can demonstrate an improving prognosis when BNP falls after therapy than when it remains persistently elevated. Cheng *et al., J. Am. Coll. Cardiol.* 37: 386-91 (2001). Thus, serial measurements may increase the prognostic value of a marker in patients with non-ST elevation ACS as well.

Assay Measurement Srategies

Numerous methods and devices are well known to the skilled artisan for measuring the prognostic indicators of the instant invention. With regard to polypeptides, such as BNP, in patient samples, immunoassay devices and methods are often used. *See, e.g.*, U.S. Patents 6,143,576; 6,113,855; 6,019,944; 5,985,579; 5,947,124; 5,939,272; 5,922,615; 5,885,527; 5,851,776; 5,824,799; 5,679,526; 5,525,524; and 5,480,792, each of which is hereby incorporated by reference in its entirety, including all tables, figures and claims. These devices and methods can utilize labeled molecules in various sandwich, competitive, or non-competitive assay formats, to generate a signal that is related to the presence or amount of an analyte of interest. Additionally, certain methods and devices, such as biosensors and optical immunoassays, may be employed to determine the presence or amount of analytes without the need for a labeled molecule. *See, e.g.*, U.S. Patents 5,631,171; and 5,955,377, each of which is hereby incorporated by reference in its entirety, including all tables, figures and claims.

Examples

The following examples serve to illustrate the present invention. These examples are in no way intended to limit the scope of the invention.

Example 1: Validation of BNP as a prognostic indicator in ACS

Study Population

The Oral Glycoprotein IIb/IIIa Inhibition with Orbofiban in Patients with Unstable Coronary Syndromes (OPUS-TIMI 16) Trial was a randomized multicenter trial comparing an oral glycoprotcin IIb/IIIa inhibitor, orbofiban, with placebo in 10,288 patients with acute coronary syndromes. Patients were included if they presented within 72 hours of the onset of ischemic discomfort and met one or more of the following criteria: dynamic ECG changes (ST deviation 0.5 mm, T-mm, T-wave inversion 3 mm in 3 leads, or left bundle branch block); positive cardiac markers; prior history of coronary artery disease; or age 65 with evidence of diabetes or vascular disease. *See, e.g.*, Cannon *et al.*, *Circulation* 102: 149-56 (2000).

The study population described in the Examples herein consisted of a subpopulation of 2525 patients from the OPUS-TIMI 16 study, of whom 825 were enrolled following an index ST elevation MI, 565 following a non-ST elevation MI, and 1133 following a diagnosis of unstable angina. BNP concentration ranged from 0-1456 pg/mL, with a mean of 114 ± 3 pg/mL, a median of 81 pg/mL, and 25th and 75th percentiles of 44 and 138 pg/mL. Mean time from the onset of ischemic symptoms to randomization was 40 ± 20 hours (median 40 hours).

Blood Sampling

Blood specimens were collected by trained study personnel in citrate tubes and centrifuged for 12 minutes. The plasma component was transferred into a sterile cryovial and frozen at -20° C or colder.

Biochemical Analyses

Troponin I, CKMB, CRP, and BNP were measured using standard immunoassay techniques. These techniques involved the use of antibodies to specifically bind the protein targets. CRP was measured using the N Latex CRP assay (Dade Behring) and fibrinogen was assayed using the Dade Behring Assay on the BN II analyzer. In the case of BNP measurements, an antibody directed against BNP was biotinylated using N-hydroxysuccinimide biotin (NHS-biotin) at a ratio of about 5 NHS-biotin moieties per antibody. The biotinylated antibody was then added to wells of a standard avidin 384 well microtiter plate, and biotinylated antibody not bound to

the plate was removed. This formed an anti-BNP solid phase in the microtiter plate. Another anti-BNP antibody was conjugated to alkaline phosphatase using standard techniques, using SMCC and SPDP (Pierce, Rockford, IL). The immunoassays were performed on a TECAN Genesis RSP 200/8 Workstation. The plasma samples (10 μL) were pipeted into the microtiter plate wells, and incubated for 60 min. The sample was then removed and the wells were washed with a wash buffer, consisting of 20 mM borate (pH 7.42) containing 150 mM NaCl, 0.1% sodium azide, and 0.02% Tween-20. The alkaline phosphatase-antibody conjugate was then added to the wells and incubated for an additional 60 min, after which time, the antibody conjugate was removed and the wells were washed with a wash buffer. A substrate, (AttoPhos®, Promega, Madison, WI) was added to the wells, and the rate of formation of the fluorescent product was related to the concentration of the BNP in the patient samples.

Clinical Endpoints

All-cause mortality and nonfatal myocardial infarction were evaluated through 30 days, and the end of the follow up period (10 months). Myocardial infarction was defined using previously reported criteria based on CKMB elevation (Antman *et al.*, *Circulation* 100: 1593-601 (1999)), and all cases of suspected myocardial infarction were adjudicated by a Clinical Events Committee. The endpoint of new or worsening CHF or cardiogenic shock was collected from case record forms.

Statistical Analyses

Subjects were divided into quartiles based on their concentration of BNP at the time of enrollment in the trial. Means and proportions for baseline variables were compared across quartiles using ANOVA for continuous variables and the $\chi 2$ trend test for categorical variables. The direct correlation between BNP and other continuous baseline variables was assessed using Pearson's test. Mean concentration of BNP was compared between patients who met a study endpoint and those who did not using the Student *t* test. Cox regression analysis was used to evaluate the association between increasing concentration of BNP and adverse cardiovascular outcomes through 30 days and 10 months. Stratified analyses were performed among patients with a cTnI level > 0.1 ng/ml and a cTnI ≤ 0.1 ng/ml, as well as those with and without a clinical diagnosis of congestive heart failure. Subgroup analyses were performed in groups defined by the following index diagnoses: ST elevation MI, non-ST elevation

ACS, and unstable angina. Quartile ranges were recalculated for each of these subgroups. For the endpoint of all-cause mortality through the end of follow-up (10 months), a logistic regression model was constructed using forward stepwise selection. Clinical variables that were assessed in > 75% of the population were entered into the model, provided they had a univariate p value < 0.1; variables were removed from the model if they had a multivariate p value > 0.1. Baseline concentrations of cTnI and BNP were then forced into the completed model. Finally, analyses were performed using a BNP threshold of 80 and 100 pg/mL (Dao *et al., J. Am. Coll. Cardiol.* 37: 379-85 (2001)).

Association with Baseline Clinical Variables

In univariate analyses, higher baseline concentration of BNP was associated with older age, female sex, white race, and a prior history of hypertension, congestive heart failure, peripheral vascular disease, and cerebrovascular disease; BNP was inversely associated with history of hypercholesterolemia and current smoking (table 1). As expected, BNP levels were highest among patients with ST elevation MI, intermediate among patients with non-ST elevation MI, and lowest among those with unstable angina (table 1). Patients with higher BNP concentrations were more likely to present in Killip Class II or greater, and were more likely to have ECG changes, elevations in cardiac biomarkers, and renal insufficiency.

Table 1
Baseline Clinical Characteristics According to Quartiles of BNP (pg/mL)

	Quartile 1	Quartile 2	Quartile 3	Quartile 4	p trend	p Q4 vs Q1
Range of BNP levels, pg/mL	0-43.6	43.7-81.2	81.3-137.8	137.9-1456.6		
n	631	632	632	630		
Time to randomization (hrs)	39 ± 21	40 ± 21	41 ± 20	41 ± 19	0.04	0.10
Age (years)	57 ± 10	59 ± 11	61 ± 12	66 ± 11	<0.0001	<0.0001
Male	474 (75%)	465 (74%)	472 (75%)	405 (64%)	0.0001	<0.0001
White	575 (91%)	592 (94%)	605 (96%)	603 (96%)	0.0002	0.001

Past Medical History						
Hypertension	246 (39%)	254 (40%)	263 (42%)	298 (47%)	0.003	0.003
Congestive Heart Failure	26 (4%)	28 (4%)	26 (4%)	56 (9%)	0.0006	0.0008
Coronary artery disease*	329 (52%)	312 (49%)	294 (47%)	327 (52%)	0.7	0.9
Peripheral vascular disease	33 (5%)	43 (7%)	48 (8%)	57 (9%)	0.008	0.009
Cerebrovascular disease	24 (4%)	32 (5%)	39 (6%)	60 (10%)	<0.0001	0.0001
Diabetes	138 (22%)	133 (21%)	132 (21%)	152 (24%)	0.4	0.3
Hypercholesterolemia	199 (32%)	191 (30%)	173 (28%)	149 (24%)	0.0009	0.002
Smoking status:					0.0002	0.001
Current smoker	233 (37%)	263 (42%)	236 (38%)	189 (30%)		
Never smoker	193 (31%)	161 (26%)	185 (29%)	254 (40%)		
Past smoker	204 (32%)	205 (33%)	209 (33%)	186 (30%)		
Index Diagnosis:					<0.0001	<0.0001
ST elevation MI	141 (22%)	189 (30%)	231 (37%)	264 (42%)		
Non ST elevation MI	87 (14%)	137 (22%)	159 (25%)	182 (29%)		
Unstable angina	402 (64%)	306 (48%)	241 (38%)	184 (29%)		
Physical findings						
BMI kg/m^2	29 ± 5	28 ± 5	28 ± 14	28 ± 12	0.1	0.08
Systolic BP (mm Hg)	130 ± 20	129 ± 19	128 ± 22	129 ± 21	0.3	0.4
Killip Class II-IV	31 (5%)	36 (6%)	56 (9%)	109 (18%)	<0.0001	<0.0001
Diagnostic Testing						
Creatinine clearance ≤ 90	146 (24%)	185 (31%)	229 (38%)	350 (58%)	<0.0001	<0.0001
CK-MB > ULN	212 (58%)	308 (72%)	349 (79%)	388 (86%)	<0.0001	<0.0001
ST depression ≥ 0.5mm	270 (43%)	297 (47%)	311 (49%)	356 (57%)	<0.0001	<0.0001

* CAD=Prior coronary artery disease: previous MI, documented unstable angina, angina pectoris, angiographically confirmed CAD, prior PTCA or CABG not for index event.
MI=myocardial infarction; BMI=Body Mass Index; ULN=upper limit of normal

Although statistically significant, the associations between the baseline concentration of BNP and C-reactive protein (R=0.2; p<0.0001), Fibrinogen (R=0.18;

p<0.0001), peak recorded CK-MB (R=0.09; p=0.0005) and LVEF (R=0.23; p<0.0001) were modest. Results from coronary arteriography, echocardiography, and exercise stress testing were available in a subset of the patient population. Higher BNP concentration was associated with more severe coronary disease, lower ejection fraction, and a positive exercise stress test (p<0.01 for each; table 2).

Table 2. Association between cardiac test results and BNP concentration

Test	1. Result	n	BNP	BNP (Mean ± SD)	p value
Coronary Angiography:	None	103	58 [32,111]	90 ± 104	<0.0001
No. vessels with ≥	1	433	73 [41,118]	92 ± 75	
50% stenosis	2	368	70 [41,120]	104 ± 112	
	≥3	405	93 [49,154]	136± 168	
LV Ejection Fraction	> 50%	718	73 [41,128]	99 ± 94	<0.0001
	≤ 50%	554	110 [59,184]	160± 182	
Stress test	Negative	374	65 [39,106]	91± 95	0.003
	Indeterminate	118	88 [49,143]	118 ± 128	
	Positive	296	88 [44,145]	118 ± 118	

LV=left ventricular; SD=standard deviation

Clinical Outcomes

Mean concentration of BNP was significantly higher among patients who died by 30 days ($p<0.0001$) or by 10 months ($p<0.0001$) vs those who were alive at either time point (table 3). These differences remained significant in subgroups of patients with ST elevation MI, non-ST elevation ACS, and unstable angina ($p<0.01$ for each subgroup at both 30 days and 10 months; table 4). Mean BNP levels were significantly higher among patients with a myocardial infarction by 30 days ($p=0.01$) or 10 months ($p=0.02$), as compared with patients free of MI at these time points (table 3). Finally, BNP concentration was higher among patients who developed new or worsening CHF by 30 days ($p<0.0001$) or 10 months ($p<0.0001$) than among those who did not develop CHF,

Table 3. Association between baseline BNP concentration (pg/mL) and outcomes

Outcome	n	Median [25,75]	Mean ± SD	p value*
30 days				
Dead	39	153 [79,294]	226 ± 204	<0.0001
Alive	2486	80 [43,135]	113 ± 124	
MI	70	109 [50,159]	152 ± 159	0.02
No MI	2455	80 [44,137]	113 ± 125	
CHF	43	159 [79,317]	252 ± 269	<0.0001
No CHF	2482	80 [43,135]	112 ± 121	
10 months				
Dead	85	143 [88,308]	228 ± 228	<0.0001
Alive	2440	79 [43,133]	110 ± 120	
MI	124	101 [50,161]	141 ± 140	0.01
No MI	2401	80 [43,134]	113 ± 126	
CHF	78	158 [82,313]	256 ± 278	<0.0001
No CHF	2447	79 [43,133]	110 ± 116	

MI=myocardial infarction; CHF=new or worsening congestive heart failure, or cardiogenic shock; SD=standard deviation; *p value from Wilcoxon Rank Sum Test

Unadjusted mortality increased in a stepwise direction across increasing quartiles of baseline BNP concentration ($p<0.0001$: figure 1). These differences remained significant in subgroups of patients with ST elevation MI, non-ST elevation ACS, and unstable angina ($p\leq0.02$ for each; figure 1). In addition, the relationship between BNP and 10-month outcomes remained graded and significant both among patients with and those without history or exam evidence of CHF at enrollment (table 4).

Table 4. Association between baseline BNP concentration (pg/ml) and 10-month outcomes in subgroups based on index diagnosis.

Outcome	n	Median [25,75]	Mean ± SD	p value*
ST elevation MI	825	96 [56,161]	131 ± 125	
Dead by 30 days	13	153 [77,265]	236 ± 220	0.003
Alive at 30 days	812	95 [56,161]		
Dead by 10 months	23	150 [90,227]	199 ± 176	0.008
Alive at 10 months	802	95 [55,161)	129 ± 123	
Non-ST elevation MI	565	98 [57,157]	136 ± 148	
Dead by 30 days	12	176 [149,327]	265 ± 206	0.001
Alive at 30 days	553	97 [56,155]	134 ± 145	
Dead by 10 months	28	176 [123,322]	245 ± 176	<0.0001
Alive at 10 months	537	95 [56,152]	131 ± 144	
Unstable Angina	1133	60 [33,105]	92 ± 111	
Dead by 30 days	14	94[69,237]	182 ± 195	0.02
Alive at 30 days	1119	60 [33,105]	90 ± 109	
Dead by 10 months	34	96 [70,265]	233 ± 292	<0.0001
Alive at 10 months	1099	58 [33,104]	87 ± 97	

MI=myocardial infarction; SD=Standard deviation; *p value from Wilcoxon Rank Sum Test

When stratification was performed based on the concentration of cTnI at the time of enrollment, increasing BNP concentration remained associated with higher 10-month mortality, both among those with a cTnI ≤ 0.1 ng/mL (n=882; p=0.01) and those with a cTnI > 0.1 ng/mL (n=1630; p<0.0001) (figure 2). After adjustment for other

independent predictors of long-term mortality, including ST deviation and cTnI, increasing concentration of BNP remained associated with a higher rate of death by 10 months (figure 3). The adjusted odds ratios for 10-month mortality were 3.9 (1.1-13.6), 4.3 (1.3-15.0), and 6.7 (2.0-22.6) for patients with BNP concentrations in the second, third, and fourth quartile, respectively (figure 3).

Evaluation of 80 and 100 pg/mL BNP Threshold

Analyses were performed using prospectively defined BNP thresholds of 80 and 100 pg/mL. Patients with a plasma concentration of BNP greater than 80 or 100 pg/mL were significantly more likely to suffer death, myocardial infarction, or new/progressive CHF than those with a BNP level lower than the selected threshold (80 pg/mL threshold: $p<0.005$ for each at 30 days and 10 months; figure 4; 100 pg/mL threshold: $p<0.005$ for each at 30 days and 10 months; figure 6). In subgroups of patients with ST elevation MI, non-ST elevation ACS, and unstable angina, a BNP level greater than either 80 or 100 pg/mL was associated with a significant increase in the risk for 10-month mortality (figures 5 and 7).

While the invention has been described and exemplified in sufficient detail for those skilled in this art to make and use it, various alternatives, modifications, and improvements should be apparent without departing from the spirit and scope of the invention.

One skilled in the art readily appreciates that the present invention is well adapted to carry out the objects and obtain the ends and advantages mentioned, as well as those inherent therein. The examples provided herein are representative of preferred embodiments, are exemplary, and are not intended as limitations on the scope of the invention. Modifications therein and other uses will occur to those skilled in the art. These modifications are encompassed within the spirit of the invention and are defined by the scope of the claims.

It will be readily apparent to a person skilled in the art that varying substitutions and modifications may be made to the invention disclosed herein without departing from the scope and spirit of the invention.

All patents and publications mentioned in the specification are indicative of the levels of those of ordinary skill in the art to which the invention pertains. All patents and publications are herein incorporated by reference to the same extent as if each

individual publication was specifically and individually indicated to be incorporated by reference.

The invention illustratively described herein suitably may be practiced in the absence of any element or elements, limitation or limitations which is not specifically disclosed herein. Thus, for example, in each instance herein any of the terms "comprising", "consisting essentially of" and "consisting of" may be replaced with either of the other two terms. The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention that in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed. Thus, it should be understood that although the present invention has been specifically disclosed by preferred embodiments and optional features, modification and variation of the concepts herein disclosed may be resorted to by those skilled in the art, and that such modifications and variations are considered to be within the scope of this invention as defined by the appended claims.

Other embodiments are set forth within the following claims.

We claim:

1. A method of determining a prognosis of a patient diagnosed with a non-ST-elevation acute coronary syndrome, the method comprising:

determining a level of B-type natriuretic peptide (BNP) in a sample obtained from said patient; and

correlating said BNP level to said patient prognosis by determining if said BNP level is associated with a predisposition to an adverse outcome of said non-ST-elevation acute coronary syndrome.

2. A method according to claim 1, wherein said adverse outcome is selected from the group consisting of death, myocardial infarction, and congestive heart failure.

3. A method according to claim 1, wherein said correlating step comprises comparing said BNP level to a threshold BNP level, whereby, when said BNP level exceeds said threshold BNP level, said patient is predisposed to said adverse outcome.

4. A method according to claim 3, wherein said threshold BNP level is at least about 80 pg/mL.

5. A method according to claim 1, wherein said sample is selected from the group consisting of a blood sample, a serum sample, and a plasma sample.

6. A method according to claim 1, further comprising correlating said BNP level with one or more additional prognostic markers associated with said patient, whereby the combination of said BNP level with said additional prognostic marker(s) increases the predictive value of said BNP or related marker level for said adverse outcome.

7. A method according to claim 6, wherein one of said prognostic marker(s) is a cardiac-specific troponin isoform concentration in a sample obtained from said patient.

8. A method according to claim 1, further comprising determining a level of cardiac-specific troponin I in a sample obtained from said patient, and correlating both said BNP level and said cardiac-specific troponin I level to said patient prognosis, whereby the combination of said BNP level with said cardiac-specific troponin I level increases the predictive value of said BNP level for said adverse outcome.

9. A method of determining a prognostic panel consisting of a plurality of prognostic markers that predict an increased risk of an adverse outcome in a patient diagnosed with a non-ST-elevation acute coronary syndrome, the method comprising:

determining a first prognostic marker comprising a level of BNP that is associated with a predisposition to said adverse outcome; and

determining one or more second prognostic markers that increase the predictive value of said first prognostic marker for said adverse outcome.

10. A method of determining a treatment regimen for a patient diagnosed with a non-ST-elevation acute coronary syndrome, the method comprising:

determining a level of BNP in a sample obtained from said patient;

correlating said BNP level to a predisposition to an adverse outcome of said non-ST-elevation acute coronary syndrome; and

determining a treatment regimen that reduces said predisposition to said adverse outcome.

11. A method of determining a prognosis of a patient diagnosed with a non-ST-elevation acute coronary syndrome, the method comprising:

determining a level of a marker related to BNP in a sample obtained from said patient; and

correlating said BNP-related marker level to said patient prognosis by determining if said BNP-related marker level is associated with a predisposition to an adverse outcome of said non-ST-elevation acute coronary syndrome.

12. A method according to claim 11, wherein said adverse outcome is selected from the group consisting of death, myocardial infarction, and congestive heart failure.

13. A method according to claim 11, wherein said correlating step comprises comparing said BNP-related marker level to a threshold BNP-related marker level, whereby, when said BNP-related marker level exceeds said threshold BNP-related marker level, said patient is predisposed to said adverse outcome.

14. A method according to claim 13, wherein said threshold BNP-related marker level is at least about 80 pg/mL.

15. A method according to claim 11, wherein said sample is selected from the group consisting of a blood sample, a serum sample, and a plasma sample.

16. A method according to claim 11, further comprising correlating said BNP-related marker level with one or more additional prognostic markers associated with said patient, whereby the combination of said BNP-related marker level with said additional prognostic marker(s) increases the predictive value of said BNP-related marker or related marker level for said adverse outcome.

17. A method according to claim 16, wherein one of said prognostic marker(s) is a cardiac-specific troponin isoform concentration in a sample obtained from said patient.

18. A method according to claim 11, further comprising determining a level of cardiac-specific troponin I in a sample obtained from said patient, and correlating both said BNP-related marker level and said cardiac-specific troponin I level to said patient prognosis, whereby the combination of said BNP-related marker level with said cardiac-specific troponin I level increases the predictive value of said BNP-related marker level for said adverse outcome.

19. A method of determining a prognostic panel consisting of a plurality of prognostic markers that predict an increased risk of an adverse outcome in a patient diagnosed with a non-ST-elevation acute coronary syndrome, the method comprising:

determining a first prognostic marker comprising a level of a marker related to BNP that is associated with a predisposition to said adverse outcome; and

determining one or more second prognostic markers that increase the predictive value of said first prognostic marker for said adverse outcome.

20. A method of determining a treatment regimen for a patient diagnosed with a non-ST-elevation acute coronary syndrome, the method comprising:

determining a level of a marker related to BNP in a sample obtained from said patient;

correlating said BNP-related marker level to a predisposition to an adverse outcome of said non-ST-elevation acute coronary syndrome; and

determining a treatment regimen that reduces said increase predisposition to said adverse outcome.

21. A method according to any one of claims 11-20, wherein said BNP-related marker is NT pro-BNP.

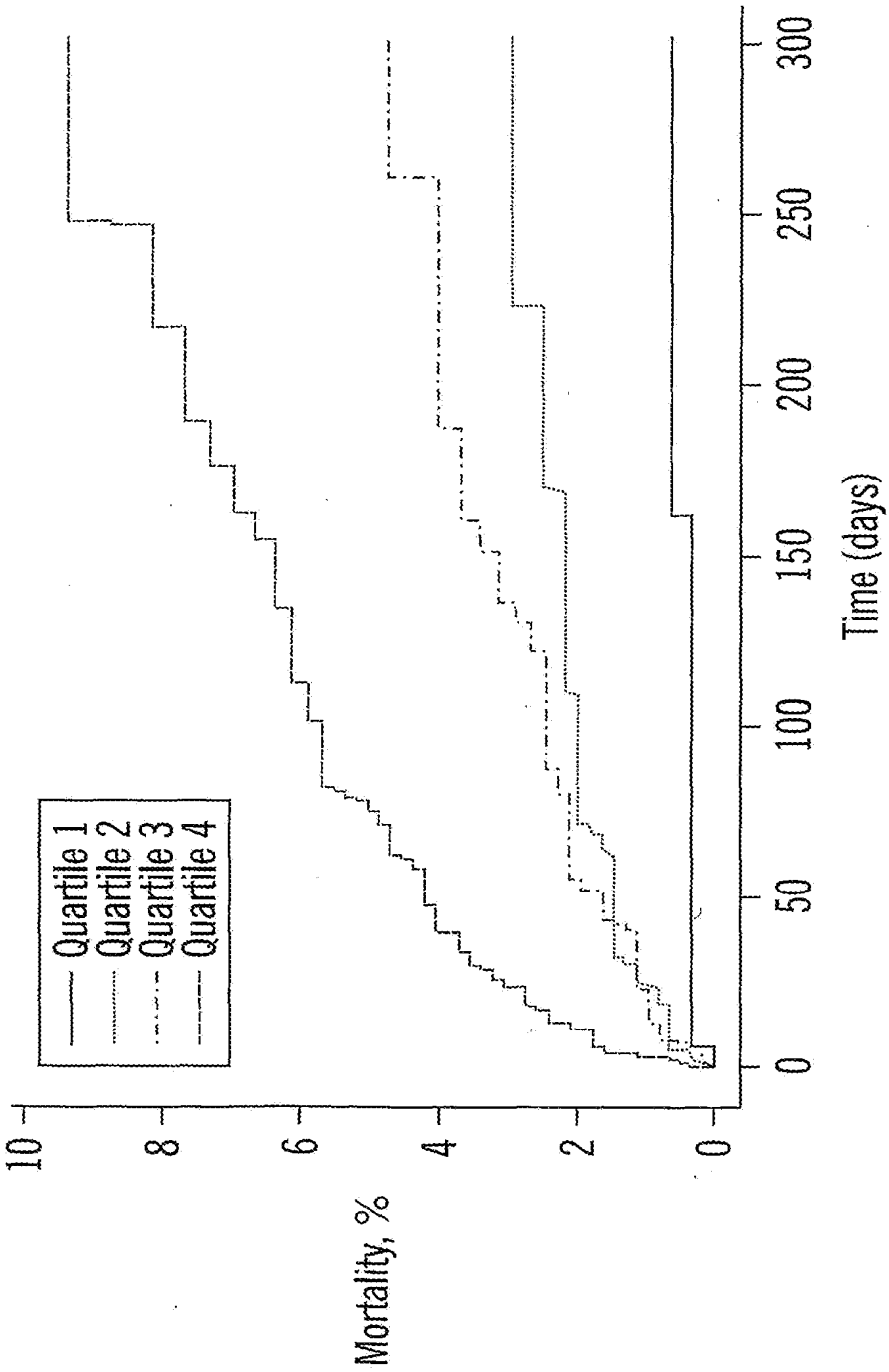
Quartile 1
Quartile 2
Quartile 3
Quartile 4
Mortality, %
0
2
4
6
8
10
0
50
100
150
200
250
300
Time (days)

FIG. 1

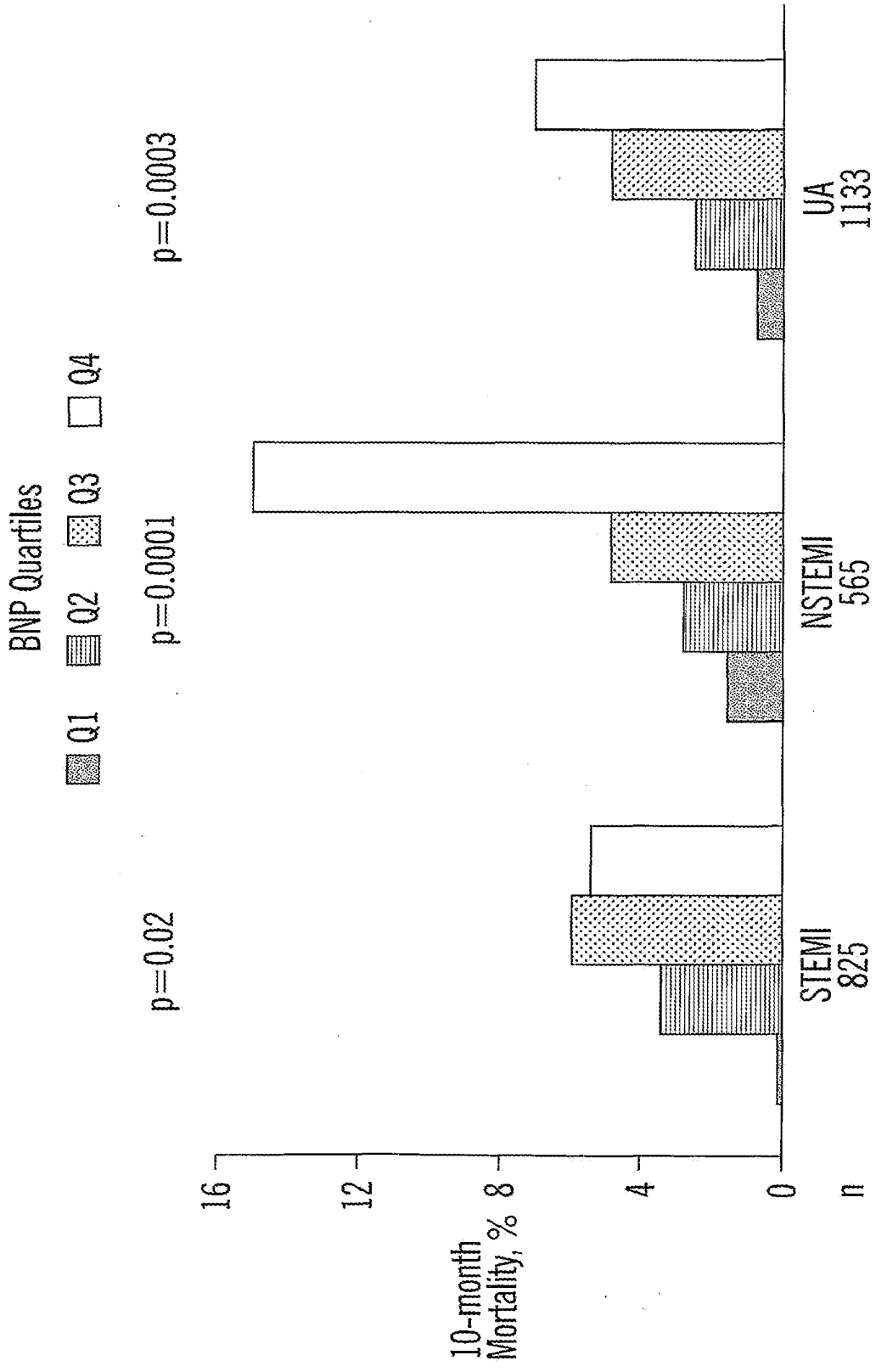
BNP Quartiles
Q1
Q2
Q3
Q4
p=0.02
p=0.0001
p=0.0003
10-month Mortality, %
16
12
8
4
0
n
STEMI 825
NSTEMI 565
UA 1133

FIG. 2

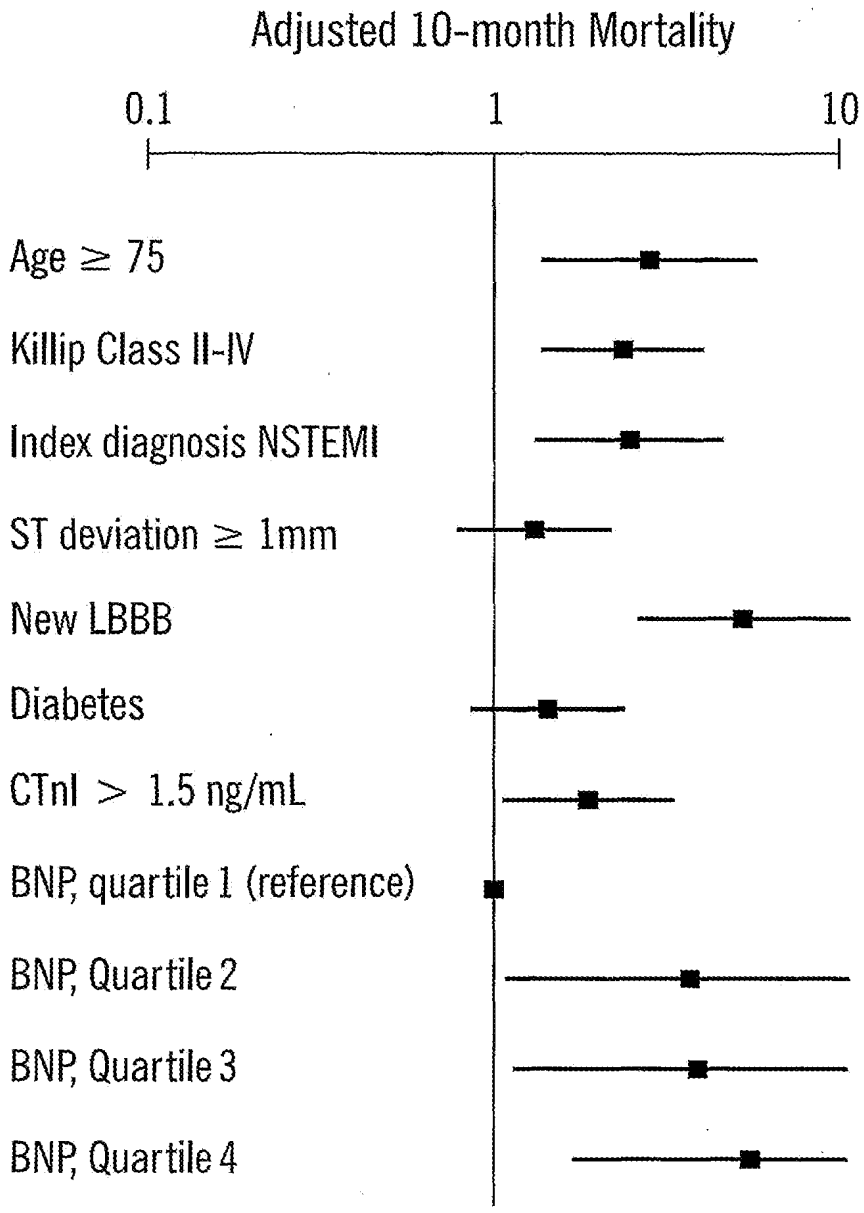
Adjusted 10-month Mortality
0.1
1
10
Age ≥ 75
Killip Class II-IV
Index diagnosis NSTEMI
ST deviation ≥ 1mm
New LBBB
Diabetes
CTnI > 1.5 ng/mL
BNP, quartile 1 (reference)
BNP, Quartile 2
BNP, Quartile 3
BNP, Quartile 4

FIG. 3

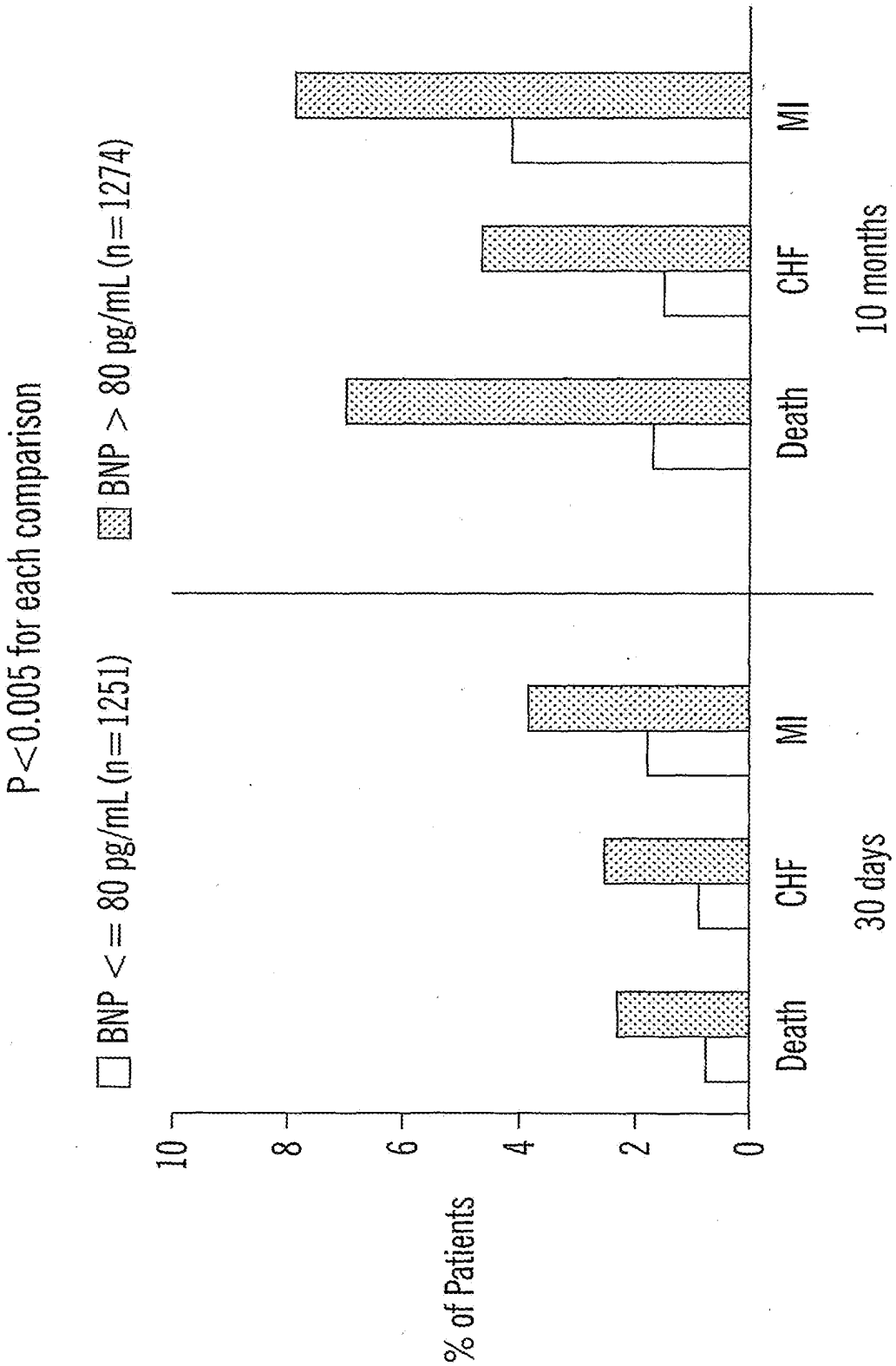
P<0.005 for each comparison
BNP <= 80 pg/mL (n=1251)
BNP > 80 pg/mL (n=1274)
% of Patients
10
8
6
4
2
0
Death
CHF
MI
30 days
Death
CHF
MI
10 months

FIG. 4

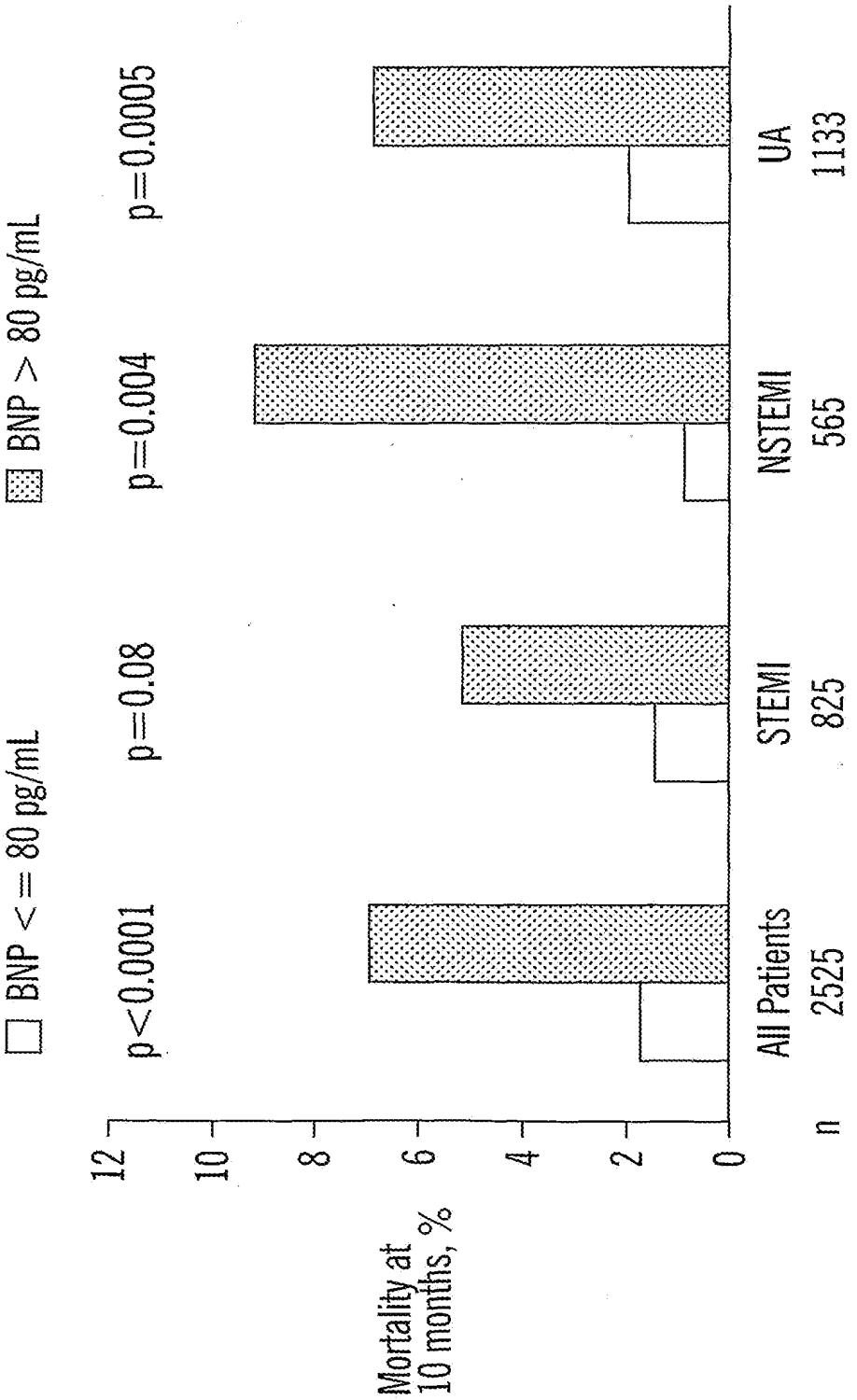
BNP <= 80 pg/mL
BNP > 80 pg/mL
p<0.0001
p=0.08
p=0.004
p=0.0005
Mortality at 10 months, %
0
2
4
6
8
10
12
n
2525
825
565
1133
All Patients
STEMI
NSTEMI
UA

FIG. 5

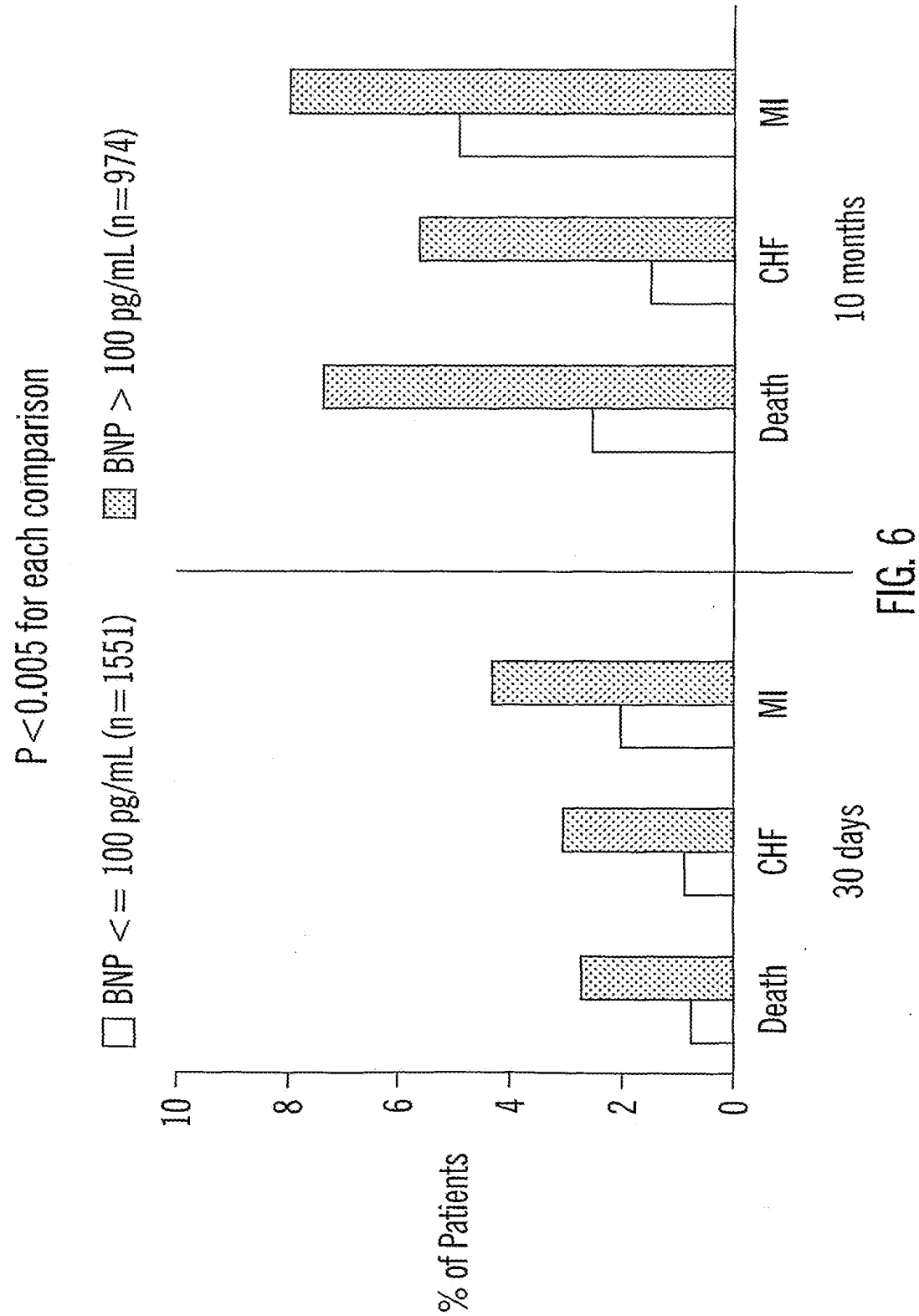
P<0.005 for each comparison
BNP <= 100 pg/mL (n=1551)
BNP > 100 pg/mL (n=974)
% of Patients
10
8
6
4
2
0
Death
CHF
MI
30 days
Death
CHF
MI
10 months

FIG. 6

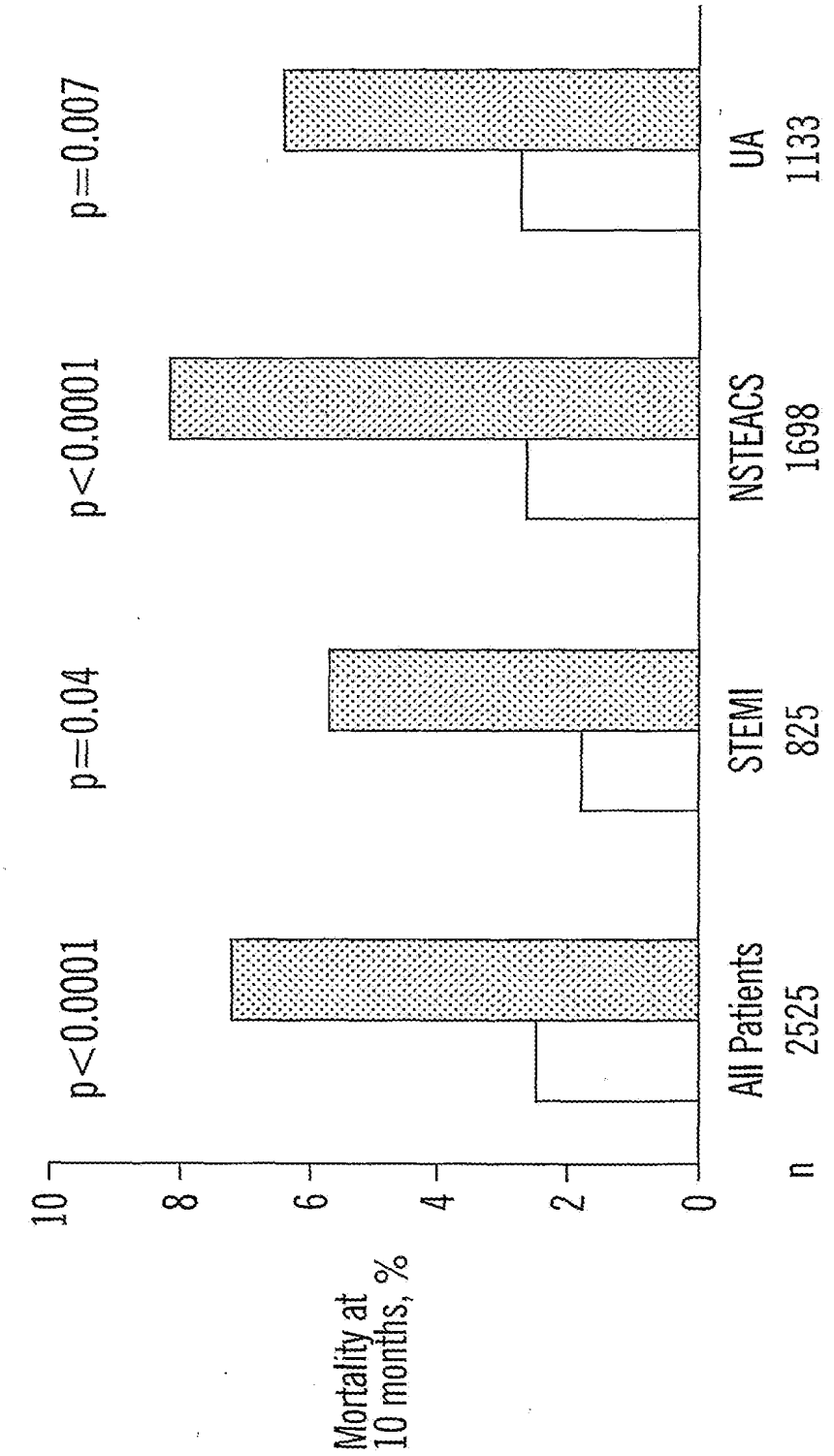
BNP <= 100 pg/mL
BNP > 100 pg/mL
p<0.0001
p=0.04
p<0.0001
p=0.007
Mortality at 10 months, %
0
2
4
6
8
10
n
2525
825
1698
1133
All Patients
STEMI
NSTEACS
UA

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/11441

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : C12P 19/34; C12Q 1/68; G01N 33/53
US CL : 435/6
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 435/6, 7.21, 7.92, 7.93, 7.94, 91, 91.1, 91.2; 436/518, 536, 811, 817, 975

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MEDLINE, EMBASE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,580,722 A (FOULKES et al.) 03 December 1996 (03.12.1996), see columns 11-51.	1-21
Y	US 6,117,644 A (DEBOLD) 12 September 2000 (12.09.2000), see entire document.	1-21
Y	US 5,786,163 A (HALL) 28 July 1998 (28.07.1998), see Summary.	1-21
Y	WO 91/09627 A1 (HEDNER et al.) 11 July 1991 (11.07.1991), see entire document.	1-21

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 May 2002 (20.05.2002)	01 JUL 2002
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Gailene R. Gabel Telephone No. (703) 308-0196

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